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THE BASAL KATABOLISM OF CATTLE AND OTHER SPECIES

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The basal katabolism of herbivora and especially of ruminants, unlike that of man or carnivora, cannot well be measured in the fasting state on account of the relatively large amount of feed always present in the alimentary canal of the former species. It may, however, be determined indirectly in the manner described by the authors[1,2,3] by measuring the total metabolism upon two different amounts of the same ration and from these data computing the level to which the metabolism would be reduced were all feed withdrawn. For example, a steer receiving two different amounts of the same mixed ration gave the following results:

	DRY MATTER EATEN DAILY	DAILY HEAT PRODUCTION
	kgms.	*calories*
Period 2	9.146	16,511
Period 1	4.463	10,905
Difference	4.683	5,606
Heat increment per kilogram of dry matter		1,197

Evidently, out of the total metabolism of 10905 Calories in Period 1, 1197 × 4.463 = 5342 Calories may be regarded as the heat production caused by the 4.463 kgm. of dry matter eaten while the remainder, 5563 Calories is the basal katabolism.

Our investigations upon the metabolism of cattle, which have been published elsewhere[3] afford data for computing in the manner just illustrated the basal katabolism of ten unfattened steers in twenty-seven experiments. In view of the very striking effect of standing in increasing the metabolism of cattle the basal katabolism per 24 hours has been computed separately from the observed rate of heat production during the intervals of lying and standing, respectively, and also for 12 hours standing and 12 hours lying per day, assumed as representing average conditions.

As was to be expected, the basal katabolism increased with the size of the animal but with very considerable fluctuations. The graphs of the results indicate an equally close relation of the basal katabolism with the weight and with the two-thirds power of the weight (computed body surface) and this conclusion is confirmed by a comparison of the coefficients of correlation as follows:

Coefficients of correlation

	WITH LIVE WEIGHT	WITH 2/3 POWER OF LIVE WEIGHT
Basal katabolism, lying 24 hours	0.8655 ± 0.0326	0.9032 ± 0.0239
Basal katabolism, standing 12 hours	0.8733 ± 0.0308	0.8710 ± 0.0313
Basal katabolism, standing 24 hours	0.8548 ± 0.0350	0.8250 ± 0.0415

Computing the basal katabolism per square meter of body surface as estimated by Moulton's formulae[4] viz.,

$$\text{For unfattened animals } S = 0.1186\ W^{5/8}$$
$$\text{For fattened animals } S = 0.158\ W^{5/9}$$

the following results were obtained.

Basal katabolism of cattle per square meter of body surface

	LYING 24 HOURS	STANDING 12 HOURS	STANDING 24 HOURS
Mean, Calories	964.0	1173.0	1365.0
Probable error of mean, Calories	± 24.0	± 21.4	± 25.7
Probable error of single result, Calories	±124.8	±110.9	±133.6
Standard deviation, Calories	185.1 ± 17.0	164.5 ± 15.1	198.0 ± 18.2
Coefficient of variability	0.1920	0.1462	0.1451

A positive correlation of the basal katabolism per square meter body surface with the live weight was also found as follows:

Coefficients of correlation with live weight

Basal katabolism per square meter	
Lying 24 hours	0.5375 ± 0.0923
Standing 12 hours	0.3666 ± 0.1124
Standing 24 hours	0.2405 ± 0.1223

The results show the marked influence of standing upon the metabolism of cattle, the mean 24 hour basal katabolism lying, standing 12 hours and standing 24 hours being in the proportion of 100 : 121 : 141, the differences largely exceeding the probable errors. Computing, from the results per square meter of surface, the basal katabolism for 12 hours standing and 12 hours lying gives as the maintenance requirement for a 1000-pound steer 5918 ± 560 Calories.

The results for the basal katabolism of man reported by Benedict, Emmes, Roth and Smith,[5] and by Means[6] present much the same picture as ours upon cattle with the exception of a much lower variability.

Coefficients of correlation

	WITH BODY WEIGHT	WITH BODY SURFACE
Total basal katabolism		
98 men	0.7263 ± 0.0320	0.7747 ± 0.0272
75 women	0.7759 ± 0.0310	0.7447 ± 0.0347

Daily basal katabolism of men and women per square meter of surface

	MEN	WOMEN
Mean Calories	830.0	768.0
Probable error of mean, Calories	± 4.3	± 4.9
Probable error of single result, Calories	±42.3	±42.8
Standard deviation, Calories	62.7 ±3.0	63.5 ±3.1
Coefficient of variability	0.0755	0.0827

Correcting for the error shown by D. and E. F. DuBois[7] to be incident to the use of the Meeh formula, the means for men and women are as follows:

Corrected daily basal katabolism of men and women per square meter of body surface

	MEN	WOMEN
Means, Calories	935.0	886.0
Probable error of mean	± 4.8	± 5.8
Probable error of single result	±47.5	±49.4

Including the data obtained by Meissl, Strohmer, and Lorenz[8] by Tangl[9] and by Fingerling, Köhler and Reinhardt[10] for swine and by Zuntz and Hagermann[11] for the horse, the following comparison of species may be made.

Mean daily basal katabolism per square meter of body surface

Men (complete muscular rest)	935 ± 5
Women (complete muscular rest)	886 ± 6
Cattle (lying)	964 ± 24
Hogs (lying)	1078 ± ?
Horse (standing quietly)	948 ± ?

Considering the nature of the results they show a rather striking degree of uniformity and tend to confirm the conclusions of E. Voit[12] that the basal katabolism of different species of animals is substantially proportional to their body surface. It may be surmised that the exceptional result with the hog is due to the imperfect data available for computing the body surface of this species.

[1] Armsby, *Washington, D. C., U. S. Dept. Agric., Bur. Anim. Indust., Bul.* **142,** 1912.

[2] Armsby and Fries, *Ibid., Bul.* **128,** 1911.

[3] Armsby and Fries, *J. Agric. Res., Washington,* **3,** 1915, (435); **10,** 1917, (599); **11,** 1917.

[4] Moulton, *J. Biol. Chem., New York,* **24,** 1916, (299).

[5] Benedict, Emmes, Roth and Smith, *Ibid.,* **18,** 1914, (139).

[6] Means, *Ibid.,* **21,** 1915, (263).

[7] DuBois and DuBois, *Arch. Inter. Med.,* **15,** 1915, (868).

[8] Meissl, Strohmer and Lorenz, *Zs. Biol., München* **22,** 1886, (63).

[9] Tangl, *Biochem. Zs.,* **44,** 1912, (252).

[10] Fingerling, Köhler and Reinhardt, *Landw. Versuchstat, Berlin,* **84,** 1914, (149).

[11] Zuntz and Hageman, *Landw. Jahrb., Berlin,* **27,** 1898, Ergzbd. III, (284).

[12] Voit, E., *Zs. Biol., München,* **41,** 1901, (113).

THE LOCATION OF THE SUN'S MAGNETIC AXIS

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The discovery by Mr. Hale in 1913 of a general magnetic field[1] surrounding the sun raised at once questions of great interest. First among these was the character of the field and the variation of its intensity over the solar surface. A preliminary investigation showed that approximately the sun may be regarded as a uniformly magnetized sphere, its axis coinciding with the axis of rotation. The minuteness of the observed quantities and the difficulties experienced in their measurement necessitated the provisional acceptance of this simple hypothesis; nevertheless, well-known peculiarities of the earth's magnetic field suggested that the solar field might deviate from that of a spherical magnet, and that its axis might be inclined to the rotation axis by an amount susceptible of measurement by special series of observations. This communication is concerned with the latter of these questions, namely, the position of the magnetic axis.

Observations of the sun's field are made by placing the slit of the spectrograph in coincidence with the central solar meridian. A compound quarter-wave plate and a Nicol prism just outside the slit serve as an analyzer, the observed effect being a minute displacement of an appropriately chosen spectral line. The amount of the displacement varies with the inclination of the lines of force to the line of sight, in other words, with the position of the sun's magnetic axis, the heliographic latitude of the point observed, and the dis-